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FOREST PLANTING LEAFLET.

HARDY CATALPA (*Catalpa speciosa*).

FORM AND SIZE.

The hardy catalpa is a tree of medium size, with slender branches forming a spreading, round-topped head. Under average conditions it grows to be from 50 to 70 feet high. In the forest it is straight and tall, and occasionally attains a height of more than 100 feet and a diameter of from 2 to 4 feet. Because of its frequent failure to form a terminal bud the catalpa has a tendency to crooked growth, and sometimes develops a short trunk with large branches close to the ground.

RANGE.

The hardy catalpa in its natural range was confined to a very limited region, extending from the valley of the Vermilion River, in Illinois, through southern Illinois and Indiana, western Kentucky and Tennessee, southeastern Missouri, and northeastern Arkansas. It was apparently distributed by backwaters along the overflow lands of the Wabash River, up near-by creeks, and down the Ohio and Mississippi rivers as far as New Madrid, Mo. In southeastern Missouri it meets the common catalpa (*Catalpa catalpa*). The latter species is indigenous to southwestern Georgia, western Florida, central Alabama, and Mississippi, but is widely naturalized and cultivated east of the Rocky Mountains, growing as far north as eastern New England.

The hardy catalpa has been planted as far north as Turner County, in South Dakota, southern Minnesota, southern Michigan, and south-

ern Massachusetts, and westward to eastern Nebraska, central Kansas, and central Oklahoma. It has done well on irrigated lands in New Mexico, Colorado, and Utah, at the lower altitudes, and where the soil is free from alkali. The present range for economic planting is on the fertile alluvial lands of the Middle West, south of the forty-first parallel of latitude. Catalpa plantations have been especially successful in the southern portion of Ohio, Illinois, and Indiana; in Nebraska south of the Platte River and east of Adams County, and in eastern Kansas.

HABITS AND GROWTH.

Catalpa requires a deep, fertile, porous soil for good growth, and it can not succeed on heavy, poorly drained land. It grows well on prairie soils and even where there is considerable sand, provided overflows are frequent or permanent water is within 10 or 15 feet of the surface. It is not adapted to poor sandy or stiff clay soils, or to those which have a tenacious gumbo subsoil. However, if a layer of clay which is not too heavy occurs beneath several feet of good soil it is of advantage, since it forms a beneficial soil foundation, retaining fertility and moisture. Catalpa will not tolerate a strongly alkaline soil. An annual rainfall of at least 25 inches is necessary for the best growth of the tree, unless it can send its roots down to the water table. Commercial plantations especially demand a good soil. It has been proved that the returns realized from a crop grown on the best soil are proportionately very much greater than those obtained from poor land in the same locality.

The hardy catalpa is very intolerant, and in dense stands the lower side branches are killed by the shade. If they become more than half an inch in diameter they cling to the tree for years after they die, thus delaying the complete pruning of the bole. New wood is deposited around the dead branch, but does not close tightly about it. The holes thus formed by the persistence of dead branches lead straight into the heart of the tree and conduct the germs of decay into the trunk. If fungus spores gain entrance, the heart decays and eventually the tree breaks down. The tendency to crooked growth and the failure to shed its limbs properly are the two most troublesome characteristics of the catalpa.

The hardy catalpa matures early and under cultivation is one of the most rapid-growing trees planted in the West. A height growth of 2½ feet and a diameter increase of one-half inch annually for the first ten to fifteen years are not unusual. It does not, however, often attain dimensions that fit it for saw logs.

Some of the trees in a plantation will be of suitable size for posts when from 8 to 10 years old, and five or six years later the entire crop should become merchantable. Good telegraph poles are grown in

from twenty to thirty years, according to the adaptability of the soil for this species.

The hardy catalpa is, as a rule, free from destructive diseases. It is subject to severe attacks of leaf-eating insects, and a number of parasitic fungi often cause considerable damage to the foliage. Root rot is rare. The wood is quite resistant to decay-producing fungi. The wood of living trees is destroyed by two fungi, one of which causes a soft rot and the other a brown rot. The soft rot is common, the other only occasional. The soft-rot fungus enters the tree through the holes caused by rotting branches and destroys the heartwood very rapidly. The wood is changed to a soft, spongy mass incapable of standing any strain, so that broken trees are common in infected plantations.

ECONOMIC USES.

The rapid growth, durability in contact with the soil, lightness, elasticity, and high fuel value of catalpa wood make the tree one of the most valuable for economic planting. Catalpa wood cut from the living tree is probably immune from attack by fungous diseases, and is one of the most durable timbers known. When used for fence posts it often remains sound for thirty to forty years. Even in young trees nearly 75 per cent of the wood is heartwood, so that when used for posts the decay of the sapwood does not materially affect the value of the post. The rich coloring of the wood makes it also well suited for cabinetwork.

The catalpa has been planted principally for fence posts and small telegraph poles. A few plantations have been made for the production of railway ties. The desirability of growing catalpa for ties has not yet been established. Experience thus far has shown that plantations can be managed most profitably on a short rotation of from fifteen to twenty years for the production of posts or small poles.

The catalpa has unfortunately been discredited in many localities because of poor results from early plantations. These were in very many cases due to the substitution of an inferior species or a hybrid for the true hardy catalpa. While the quality of the wood is somewhat similar, the common catalpa and its hybrids are much less hardy than *Catalpa speciosa*, are less erect in habit, and have a marked tendency to branch low.

METHODS OF PROPAGATION.

The catalpa reproduces by seed and by sprouts from the stump. In starting a commercial plantation seedlings should be used, and these may be grown at home at comparatively small cost.

Seed may be purchased, but it is advisable for the planter to col-

lect his own supply, if possible, since seed from certain undesirable species, more prolific than the hardy catalpa, has been sold extensively by dealers as genuine. The seed ripens in the autumn and the pods ordinarily hang on the trees all winter. It is well, however, to gather the pods as soon as the leaves fall, since some of them are likely to open and drop their seeds. The seed should be kept over winter in the pods, in cool, dry storage. Sowing should be done early in the spring, but not until the ground has become warm. Drills should be made in well-prepared, mellow soil, and the seeds sown a half inch apart and covered to a depth of about 1 inch. The rows should be far enough apart to allow thorough cultivation. Under average conditions the seedlings will grow 12 to 24 inches in height during the first summer, and will be suitable for planting the following spring.

One pound of hardy catalpa seed contains nearly 20,000 seeds, which will be sufficient to sow about 8,000 linear feet of drills. Between 40 and 75 per cent of the fresh seed should germinate, and a pound may be expected to produce about 12,000 one-year-old plants.

PLANTING.

The planting site should be prepared by plowing and harrowing in the spring, and there is an advantage in growing a field crop on the site for one season before planting. It is usually advisable to plant 1-year-old stock in the spring. In the South, however, where the winters are mild, catalpa may be planted with safety in the fall, after one season's growth in the nursery.

Proper spacing of the trees in the plantation depends to some extent upon regional and site conditions. East of the Mississippi catalpa may be planted 6 by 8 feet or 8 feet apart each way, but in the plains region it will be well to set the trees 4 by 8 feet or 6 feet apart each way. A spacing of 4 by 4 feet is advisable only when early thinnings can surely be made. In general this very close spacing should not be used, because the catalpa requires considerable room for lateral root development, and crowding will tend to lessen the vitality of the trees and to lower the rate of growth.

In raising catalpa the object is to obtain the best growth and most perfect form in the shortest possible time. To accomplish this a relatively wide spacing of the trees, supplemented by a limited amount of artificial pruning, is necessary.

While catalpa has thus far been planted chiefly in pure stands, an associate tree may prove desirable in the Middle West. This should be of a tolerant species and slower growing than the catalpa. This associate tree, or "filler," would complete the crown cover and would assist in pruning the catalpa and in forcing straight upward growth. Two species that are well adapted for planting with catalpa in the West are Russian mulberry and Osage orange.

CULTIVATION AND CARE.

Catalpa requires especial care if the best results are to be secured. Waste land and rocky hillsides are not suited to catalpa growing. In forest planting for profit such sites should be planted with saw-timber species and the catalpa confined to some area of good arable land, set aside expressly for the production of fence posts and small material.

It is usually advisable to cultivate plantations during the first three seasons, although in regions of abundant rainfall they may be planted with cowpeas or soy beans or sown to crimson clover after one season's cultivation. The disk harrow is the most suitable implement for the first cultivation, after which a common harrow may be used. The soil should be stirred often enough to maintain a good dust mulch for conserving moisture. After the first year cultivation should be shallow, so as not to mutilate the roots of the trees, and during the third season it may not be feasible at all, since by that time the ground between the rows will often be filled with a network of roots.

Except in the South, on rich soils, where height growth is especially vigorous, the young trees should be cut back to the ground during late winter or early spring after one or two seasons of growth in the plantation. A number of sprouts will spring up from the stump during the following spring, all of which should be removed during the early part of the growing season except the most vigorous one. Care should be taken not to tear the bark when removing the sprouts. The surviving stem should make a straight branchless growth of from 6 to 10 feet the first season, and will largely do away with the necessity of pruning. Cutting back offers the simplest means of producing straight trunks, and without retarding ultimate height growth, it accomplishes the same object as pruning at less expense.

If pruning is undertaken it should be done late in the winter or in early spring before growth starts. In no case should catalpa trees be pruned to a whip. All trees which become severely injured in any way, as by wind, fire, or animals, should be cut back to the ground without delay.

In case the trees have been planted as closely as 4 feet apart it will be necessary to commence thinning the plantation in about four to six years, and before any of the stems will be marketable except for stakes. If, however, a wider spacing has been used and proper care and attention given the plantation, thinnings will not be needed until eight to ten years after planting, when many of the trees will yield one or two posts each.

Between the ages of 15 and 20 the entire plantation may be cut clean for posts and a new forest allowed to start from the stump sprouts, or it may again be thinned and the best trees left standing

to produce poles. If this latter plan is followed, however, the stump sprouts are likely to be less vigorous than if all the trees were cut.

In the Middle West the catalpa is often injured by strong, steady winds, which whip off the leaves, dry out the soil, and cause crooked and deformed growth. Plantations should, therefore, be protected by setting out several rows of hardier species along the exposed sides, a mixture of species being best. A good combination would be two rows of Russian mulberry or Osage orange adjoining the plantation with a row of cottonwood on the outside. The mulberry should be spaced 4 by 4 feet and the cottonwood 8 by 8 feet.

If protection from fires is necessary, it should be given by plowing a fire guard of half a dozen furrows around the plantation each year. If the plantation is large, it is better to divide it into blocks of 40 to 50 acres each by means of lanes 15 to 20 feet wide. These lanes should be kept plowed, so that fire can not spread from one block to another. This system also gives easy access to the interior of the plantation.

Soft rot of the catalpa can not be checked after a tree is infected, but proper treatment of the plantation will prevent it. Trees that are only partially rotten may be cut and used for posts, since the fungus ceases to work as soon as the tree is cut. Methods of planting, cutting back, or pruning which produce a clean, straight growth of the tree free from low side branches give the fungus no chance to enter unless a wound is caused in some unusual way.

If the plantation is threatened by insect attacks, specimens should be sent to the Bureau of Entomology of the Department of Agriculture for identification and advice as to remedial measures.

RETURNS.

Catalpa has been planted under such a wide range of conditions that the returns have not been at all uniform. Profits from catalpa growing depend most upon the suitability of the planting site, upon proper spacing, and especially upon the cultivation and care of the plantation.

The following figures on the yield of hardy catalpa under a variety of conditions indicate in a general way the returns which may be expected from plantations:

Two plantations in Marion County, Mo., in which the trees were spaced 4 by 8 feet when set out, contained, respectively, 392 trees and 616 trees per acre at the end of twenty years. The average height of the trees in the first grove was 47 feet, with a diameter, breast high, of 7.5 inches; those in the second grove were 55 feet, with a diameter of 7 inches. The products per acre of the first grove were 1,568 first-class posts, 392 second-class posts, and 1.9 cords of

fuel wood; of the second grove, 3,038 first-class and 616 second-class posts, and 4.8 cords of fuel wood.

A plantation in Sangamon County, Ill., in which the original spacing was 4 by 5 feet, contained at 21 years of age 800 trees, with a yield per acre of 1,920 posts, all first class, and 4.9 cords of fuel wood. The cost of establishing a plantation in Illinois under present conditions is about \$15 per acre.

A 17-year-old plantation in Washington County, Iowa, in which the trees had been set 4 feet apart each way, was found to contain 1,312 trees per acre over 4 inches in diameter breast high. The average diameter of these trees was 5.7 inches, and the estimated yield of the stand was 2,778 first and second class posts per acre. The effect of the quality of the soil upon the yield of catalpa is well shown by a 21-year-old plantation in Iowa County, Iowa. The original spacing of the trees was 9 by 5 feet, and on good soil there remained 524 trees per acre which had a diameter of 4 inches or over breast high. The estimated yield was 1,896 posts and 96 poles. A portion of the stand which was growing on a sandy knoll contained only 380 trees per acre, with a yield of but 572 posts.

A 25-year-old plantation in Nemaha County contained 747 dominant trees per acre, with an average diameter breast high of 6.6 inches, and an estimated yield of 1,829 first-class posts, 845 second-class posts, and 1.9 cords of wood.

In York County, Nebr., which is near the western limit of the range for economic planting, a 21-year-old plantation contained 406 dominant trees per acre. The average diameter of the trees was 4.7 inches, and the yield was limited to 242 first-class and 140 second-class posts, and 0.4 cord of wood.

In a plantation in Pawnee County, Nebr., the owner kept a strict account of all expenses incurred in establishing, maintaining, and harvesting his plantation, and of the final proceeds. The seedling trees, at \$1.15 per thousand, cost \$3.13 an acre; the preparation of the ground, planting, cultivating, and pruning cost \$18.46—a total of \$21.59 per acre. At 5 per cent compound interest this was increased, in the sixteen and one-third years during which the plantation grew, by \$26.34. Cutting and marketing the crop added \$61.90 per acre to this, so that the full cost at the end of the experiment for the 20 acres was \$2,196.

The returns were:

31,397 third-class posts, at 5 cents-----	\$1, 569. 85
17,349 second-class posts, at 10 cents-----	1, 734. 90
4,268 first-class posts, at 12½ cents-----	533. 50
270 first-class posts, at 15 cents-----	40. 50
211 8-foot posts, at 20 cents-----	42. 20

9 10-foot posts, at 25 cents-----	\$2. 25
4 10-foot posts, at 30 cents-----	1. 20
258 10-foot posts, at 35 cents-----	90. 30
41 12-foot posts, at 40 cents-----	16. 40
167 14 and 16 foot poles, at 50 cents-----	83. 50
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Total for posts and poles-----	4, 114. 60
214 cords of wood, at \$5.25-----	1, 123. 50
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Total income from 20 acres-----	5, 238. 10

The total profit was, therefore, \$3,042.19, or \$152.17 per acre, equal, with allowance for 5 per cent compound interest, to \$6.24 an acre.

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